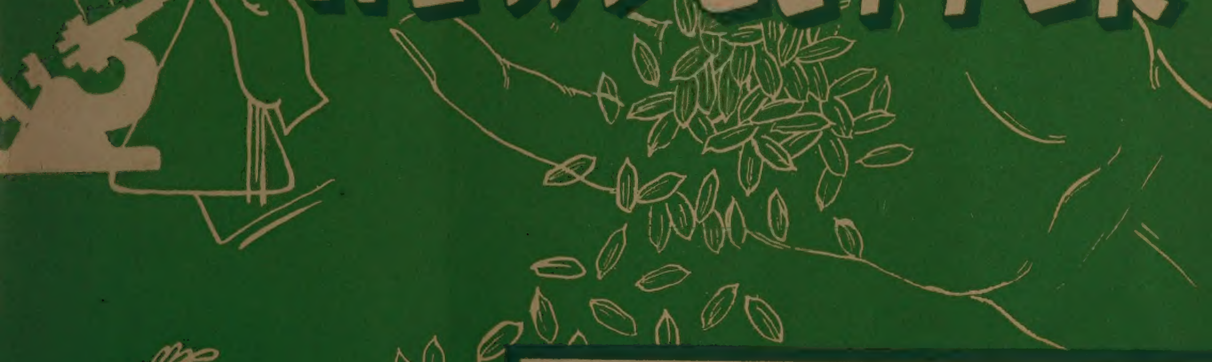
INTERNATIONAL RICE COMMISSION

NEWSLETTER



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FOOD AND AGRICULTURE ORGANIZATION
REGIONAL OFFICE FOR ASIA AND THE FAR EAST
BANGKOK THAILAND

FERTILIZER TRIALS IN CULTIVATORS' FIELDS IN CEYLON

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I. Introduction

Fertilizer trials in cultivators' fields were first started in Ceylon in 1955. The early trials, which were limited in scale and exploratory in character, served to indicate the methods and organization necessary for elaborate experimentation in cultivators' fields under Ceylon conditions.

With the experience gained from the first two seasons' trials, a comprehensive scheme of fertilizer experiments in cultivators' fields was launched during the season October 1956 – March 1957. One thousand seven hundred and twenty plots were laid out at 128 locations scattered in 63 ranges (regional units) during this season. The scope of the trials was increased with each successive season, and to date has embraced the following kinds of experiments: (i) forms and levels of nitrogen; (ii) top dressing trials with ammonium sulphate; (iii) forms of phosphate; (iv) levels of nitrogen in conjunction with levels of phosphate; (v) liming trials; and (vi) complex trials involving levels of nitrogen, phosphorus and potassium. This paper describes the organization and techniques of the scheme, and reports the results of the trials up to August, 1958.

II. The Scheme

The experiments were planned by the Chemistry Division of the Department of Agriculture in consultation with the statistician and executed by the extension staff with the cooperation of the cultivators. The regional unit for these trials was the "range". The range officers worked under the district extension officers, but carried out these trials as part of their duties.

An administrative area rather than the soil type or phase was taken as the unit within which the trials were located at random, because (1) the classification of hydromorphic soils has not proceeded far enough to permit accurate characterization of soil types under paddy land conditions, and (2) it was easier to administer the scheme if the existing extension organization was used.

Procedure. Within each regional unit, a list of "yayas" (paddy tracts), that satisfied the following requirements was made each season: (i) was more than 25 acres in area; (ii) had an assured water supply; and (iii) was not subject to excessive flood damage. From this list, five "yayas" were selected at random. Within each of these yayas, five holdings were selected at random. The details of the selected holdings were communicated to the range officer together with full instructions on the experiments and the randomizations of the treatments within each blocks. The range officer was instructed to arrange for the trial or trials in the first of these holdings. If for some reason this was not possible, he had instructions to proceed to the next. And so on.

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The plot size recommended was 35' x $18\frac{1}{2}'$ to give a net harvested area of one eighth of an acre when a border of one foot was left out. If the necessary number of plots of this size could not be accommodated within a single " liyadde ", he was allowed to reduce the plot size slightly, but in no case was it to be less than 0.01 acre. In exceptional circumstances he was permitted to lay out the plots of a single block in two or more adjacent " liyaddes ".

The plots were pegged out by the range officer after the final levelling, and the small ridges by which the plots were bounded were made by the cultivators. The lay out of the plots was checked in the field wherever possible. Failing that, sketches of the lay out of the plots were scrutinized and necessary amendments suggested.

On satisfactory completion of the lay out and receipt of information on the probable date of sowing or transplanting, the fertilizers for each plot were mixed, weighed, packeted, numbered and despatched with full identification details. All that the range officer had to do was to take the parcel of fertilizer packets meant for a block at a particular location to the site of the experiment and apply the contents of each packet to the appropriate plots just before planting. Two thirds of the nitrogen was sent in a separate packet for top dressing 30 days before heading. The fertilizer was supplied free.

In the early stages of the scheme it was considered inexpedient to press for obviously desirable practices such as the use of high yielding varieties, transplanting etc. But, with the increasing interest manifested in these trials, it has become possible now to persuade the cultivators to adopt these practices. The necessary pest and disease control measures were carried out by the range officer or his assistants, and a log book was kept of each trial.

Each plot was separately harvested, threshed, winnowed and weighed under the supervision of the range officer. A sample of paddy from each plot was sent in an air-tight container to the Chemistry Division for determination of losses in weight on sun drying. The harvest figures were sent with the log book to the Chemistry Division, where the statistical analysis was done after the necessary correction of each plot yield for losses on sun drying.

Designs. The early experiments were laid out as simple randomized blocks replicated in locations. Wherever the number of replicates permitted, the results of an experiment were analysed rangewise. Otherwise, the results from two or more adjacent ranges were pooled.

III. Results

Forms of nitrogen trials. Ammonium sulphate, the nitrogenous fertilizer most widely used on rice, has certain disadvantages. They are: (i) it aggravates the problem of hydrogen sulphide toxicity on rice soils low in easily reducible iron; (ii) its manufacture in Ceylon presents certain difficulties; (iii) its transportation charges per unit of nitrogen are about twice those of the newer fertilizers, urea and ammonium nitrate.

The nitrogen trial was in the form of a 3^3 factorial, replicated in 88 locations, in which the response to ammonium sulphate, urea and ammonium nitrate were studied

at the three levels, 0, 30, and 60 lbs. nitrogen per acre over a basal dressing of 40 lbs. P_2O_5 and 50 lbs. K_2O per acre. The soils were imperfectly to moderately well drained strongly acid lateritic clays and loams. The responses are summarized below.

Form of Nitrogen	Mean yields (bushels/acre)
Urea	62.3
Ammonium nitrate	63.5
Ammonium sulphate	72.7
S.E	1.4

Level of N (lbs/acre)	Mean yields (bushels/acre)
0	57.4
30	62.4
60	69.7
S.E	1.4

The responses both to forms of nitrogen and to levels of nitrogen were very highly significant. The responses were also consistent in all locations. Ammonium sulphate gave the best response. The difference between urea and ammonium nitrate was not significant. The response to nitrogen over the range 0 to 60 lbs. N per acre was linear and was 9 lbs. paddy per lb. of N.

Forms of nitrogen trials, which include ammonium phosphate, are in progress in 46 locations.

Top dressing trials with ammonium sulphate. Large tracts of paddy fields under the major irrigation schemes in Ceylon usually receive no fertilizers. On these relatively productive soils, it was surmised that top dressing with nitrogen alone, 30 days before heading, would give a substantial increase in yield.

The responses to 0, 100 and 200 lbs. per acre of ammonium sulphate, alone applied as a top dressing 30 days before heading, were studied in randomized blocks of three plots replicated at three locations in each of the six ranges under trial. The results are summarized in Table 1.

Table 1. Mean yields of top dressing trials (bushels per acre)

Range	Ammonium sulphate in lbs/acre		
	0	100	200
Tissamaharama	43.53	47.41	51.51
Walawe Left Bank	37.70	39.94	43.85
Minipe	45.34	53.12	60.00
Minneriya	50.50	66.65	60.71
Nuwaragam Palata West	52.08	80.20	70.05
Tangalle	53.69	66.09	63.80

Top dressing with 100 lbs. per acre of ammonium sulphate gave a significant increase of 11.8 bushels per acre or 25 per cent higher for the six ranges. Top dressing with 200 lbs. per acre of ammonium sulphate gave a significant increase of 4.8 bushels

per acre over top dressing with 100 lbs. per acre of ammonium sulphate in Tissamaharama, Walawe Left Bank and Minipe, while at Minneriya, Nuwaragam Palata West and Tangalle the higher level of nitrogen application was not as good as the lower.

Forms of phosphate trials. The form of phosphatic fertilizer is relatively unimportant for lowland rice, because the availability of phosphate is high in reduced soils. The cheapest form of phosphate may therefore be used on such soils.

The response to five forms of phosphate, viz., rock phosphate (saphos), ordinary super phosphate, concentrated superphosphate, basic slag and bonemeal (3/32" grade), at 40 lbs. per acre and P_2O_5 over a basal dressing of 200 lbs. per acre of ammonium sulphate and 100 lbs. per acre of muriate of potash, was studied in randomized blocks of six plots replicated at seven locations during the season April-September 1957, and at 85 locations during October 1957-March 1958. The yields are summarized below.

April-September 1957 Trials

Treatment	Mean yield (bushels/acre)
No phosphate	40.74
Rock phosphate (saphos)	51.06
Ordinary superphosphate	51.84
Concentrated superphosphate	52.56
Basic slag	52.26
Bone meal (3/32")	50.24
40 lbs. P_2O_5 per acre	51.59

There were no significant differences among the forms of phosphatic fertilizers. The response to 40 lbs. P_2O_5 per acre was nearly 11 bushels per acre or 27 per cent over the control.

The season October 1957 - March 1958 was a season of unusually heavy rainfall over the greater part of the island and disastrous floods in the northern and eastern parts. The results of the trials of this season are summarized in Table 2.

Table 2. Mean yields of the different forms of phosphate trials in the season October 1957-March 1958 (bushels per acre)

District or Range	No. of locations	Control	Rock phosphate	Ord. super phosphate	Conc. super phosphate	Basic slag	Bone meal	S.E.	Mean response to 40 lbs. P_2O_5 per acre
Colombo	11	36.31	36.13	36.38	37.72	39.20	37.86	1.15	1.2
Kalutara	8	22.89	26.80	25.85	25.69	26.30	21.97	1.44	2.5
Galle–Matara	4	37.99	39.26	43.26	43.87	40.96	38.71	3.03	3.3
Kegalle	6	41.74	42.04	40.07	47.18	44.44	44.84	2.28	2.0
Kandy	6	46.52	62.61	53.41	55.14	62.07	52.70	3.66	10.7
Mirigama	13	49.57	48.57	49.98	49.77	49.99	49.32	1.78	0
Minipe	5	53.98	51.75	53.27	51.31	46.95	52.04	2.52	2.9
Balangoda	5	40.94	54.75	56.07	50.18	55.54	56.81	3.54	13.7

There were no significant differences among the forms of phosphate used in any of the eight districts. The response to 40 lbs. of P_2O_5 per acre, during this unusual season, was significant only in the Kandy District and Balangoda Range by an increase of 10.7 and 13.7 bushels per acre respectively.

Trials with nitrogen and phosphorus. These trials were designed to obtain information on (a) the response to three levels of nitrogen, (b) the presence or absence of a response to phosphorus, and (c) any N x P interaction.

The design was a 3 x 2 factorial, in which the levels were: 0, 40, and 80 lbs. nitrogen as ammonium sulphate; and 0 and 80 lbs. P_2O_5 as concentrated superphosphate. All plots received a basal dressing of 100 lbs. per acre of muriate of potash. The nitrogen was applied in two doses: one third at planting and two thirds 30 days before heading. The experiment was laid out in randomized block of six plots replicated at 8 locations in the season April-September 1957 and at 56 locations in October 1957-March 1958.

The April-September 1957 trials indicated very highly significant responses to the three levels of ammonium sulphate and to concentrated superphosphate at 40 lbs. per acre of P_2O_5. The N x P interaction was non-significant. The results are summarized in Table 3 and 4.

Table 3. Responses to nitrogen

Nitrogen (lbs/acre)	Mean yield (bushels/acre)	Increase (bushels/acre)	Percentage increase over no nitrogen
0	43.9	—	—
40	51.0	7.1	16.2
80	54.9	11.0	25.1

Table 4. Responses to phosphorus

P_2O_5 (lbs/acre)	Mean yield	Increase	Percentage increase over no P_2O_5
0	46.3	—	—
40	53.3	7.0	15.0

Forty pounds per acre of nitrogen gave an average increase of 7.1 bushels per acre or 16.2 per cent, and 80 lbs. of N gave an average increase of 11 bushels per acre or 25.1 per cent. Phosphorus at 40 lbs. per acre of P_2O_5 gave an increase of 7 bushels per acre or 15 per cent.

The same trial was laid out at 56 locations during the season October 1957-March 1958. Owing to flood damage the results from only 24 locations could be analysed. The results are summarized in Table 5.

Table 5. Mean yields of October 1957-March 1958 N.P trials (bushels/acre)

District	No. of locations	Levels of N (lbs/acre) 0	40	80	Levels of P_2O_5 (lbs/acre) 0	40	Response to 40 lbs. P_2O_5
Colombo	6	30.2	31.4	26.9	28.1	30.3	2.2
Kalutara	4	26.9	25.3	26.5	26.7	25.5	1.2
Kandy	5	60.5	65.7	70.4	59.7	71.5	11.8
Bolangoda	4	49.1	53.8	49.4	45.8	55.7	9.9
Minipe	5	45.9	45.2	43.5	43.9	45.8	1.9

During this season of exceptionally heavy rainfall, the responses to levels of nitrogen were not significant in any one of the ten districts under test. The response to 40 lbs. per acre P_2O_5 was significant only in the Kandy District and Balangoda Range. It is interesting to note that responses of the same order to 40 lbs. per acre of P_2O_5 were obtained in the form of phosphate trials in the same season (vide page 4). The relatively low yields of the Colombo and Kalutara Districts in these trials, as in the form of phosphate trials, reflect the presence of certain limiting factors in these two districts. One of these was blast disease, which was aggravated by fertilizers applications.

N,P,K Trials. These trials were used to determine the optimum combination of N, P, & K for each of the ranges under test.

The levels were:

N - 0, 30, 60 lbs N as ammonium sulphate

P - 0, 20, 40 lbs P_2O_5 as rock phosphate

K - 0, 50 lbs K_2O as muriate of potash.

The response of rice to fourteen of the eighteen possible treatment combinations was studies in five incomplete blocks of six plots each at locations taken at random within each range. The conclusions from the results available to date are shown in Table 5.

IV. Statistical Conclusions

Matara (Weligama): All fertilizers gave significantly higher responses than the control, except potash which caused a significantly depressing effect on yield. Among the fertilizers, N_1P_1 and N_2P_2 gave the best yields of about 50% more than the control. The second level of nitrogen when applied alone appeared to have a tendency to depress yields.

Kandy (Udunuwara - Yatinuwara): All fertilizers gave significant responses except potash. Among the fertilizers N_2P_2 gave the best yields of about 75% more than the control.

Kegalle (Beligal Korale): Except potash and phosphate at the first level, all other fertilizers gave significant responses. Among the fertilizers N_2, N_1P_1, N_1P_2 and N_2P_2 gave the best yields with N_2P_2 giving the highest yields of about 50% more than the control.

Galle (Bentota - Wellalawita Korale): There appeared to be no significant response to fertilizers, except to P_1, N_1P_1,

N_1P_2 and N_2P_2, with N_1P_2 giving the highest average yield. The increase in yield was about 30 per cent over the control.

Ratnapura (Eheliyagoda): All fertilizers, except phosphates applied alone or potash applied alone, gave significant responses. Among the fertilizers, N_2 and N_2P_2 gave the best responses of about 100 per cent more than the control.

Kandy (Patadumbara): All fertilizers except potash gave significant responses. Among the fertilizers N_1P_2 and N_2P_2 gave highly significant responses. N_2P_2 gave an increase of about 65 per cent more than the control.

Kegalle (Mawanella): There was no significant response to any of the fertilizers applied.

Kalutara (Kalutara): There was no response to phosphates applied alone or potash applied alone. Among the fertilizers which gave a significant response, viz: N_1 alone and N_2P_2, N_2P_2 gave the highest yield – and increase of about 25% over the control.

V. Summary

Fertilizer trials in cultivators' fields have been conducted in Ceylon with the cooperation of the statistician, extension staff and cultivators since 1955.

On moderately well drained acid lateritic soils, ammonium sulphate was superior to urea and ammonium nitrate; there was no appreciable difference between urea and ammonium nitrate. On these soils, the response to nitrogen was linear in the range 0 - 60 lbs. nitrogen per acre, and averaged 9 lbs. paddy per lb. of nitrogen.

Top dressing (with 100 lbs. ammonium sulphate) of unfertilized fields in the dry zone, with an assured water supply, gave an increase of nearly 12 bushels per acre or 25 per cent.

There was no significant difference among the following phosphatic fertilizers, rock phosphate, ordinary superphosphate, concentrated superphosphate, basic slag, and bone meal. The response to 40 lbs. per acre of P_2O_5 ranged from 7 - 11 bushels per acre or approximately 25 per cent on the paddy soils of the mid country and the dry zone. The responses obtained in the low country ultra wet zone were smaller and non-significant.

In trials with N and P, significant average responses of the order of 7 bushels per acre (16 per cent) and 11 bushels per acre (25 per cent) to 40 lbs. per acre of N and to 80 lbs. per acre of N, respectively, were obtained. The average response to 40 lbs. per acre of P_2O_5 in these trials was 7 bushels per acre or 15 per cent. There was no response to N or P on the poorly and imperfectly drained soils of the low country ultra wet zone.

The N, P, K trials of Yala 1958 showed that a combination of 60 lbs. per acre of nitrogen and 40 lbs. per acre of P_2O_5 was the best fertilizer combination for the following ranges: Yatinuwara-Udunuwara (Kandy District), Beligal Korale (Kegalle District), Pata Dumbara (Kandy District), Kalutara (Kalutara District). There was no response to potash in any of the eight ranges.

Table 5. Average yields of fertilizer trials in cultivators' fields - Yala 58/59 (bushels/acre)

District	Range	Control	% increase over control	Different treatments N_1	N_2	P_1	P_2	K_1	N_1P_1	N_1P_2	N_2P_2	Best yielding combination
Matara	Weligama	32.98	34.2	40.24	36.56	40.69	41.78	22.77[3]	44.32[2]	40.36	43.16[2]	N_1P_1
Kandy	Yatinuwara - Udunuwara	20.32	79.8	26.16	29.37	25.74	30.68	20.61	31.42	32.46	36.51[1]	N_2P_2
Kagalle	Beligal Korale	31.35	44.3	36.53	40.20[2]	32.33	37.85	30.23	41.20[2]	40.70[2]	45.32[1]	N_2P_2
Galle	Bentota-Wellalawita Korale	24.12	25.7	26.20	26.75	29.14[2]	26.44	23.85	30.32[1]	31.88[2]	30.04[2]	N_1P_2
Ratnapura	Eheliyagoda	13.54	98.8	19.26	26.93[1]	13.38	14.28	12.80	19.55	19.40	26.11[1]	N_2 alone
Kandy	Patadumbara	39.50	52.7	46.46	41.19	44.63	49.78	40.01	41.11	50.73[1]	60.33[1]	N_2P_2
Kegalle	Mawanella	34.06	–	33.81	35.92	35.22	32.68	36.55	31.01	34.00	35.34	–
Kalutara	Kalutara	44.28	24.8	36.34	47.65	42.15	43.42	42.93	41.13	38.00	55.30[1]	N_2P_2

1 Significant at 1% level
2 Significant at 5% level
3 Significantly depressing effect

Note : (i) The asterisks denote significant responses among the fertilizers themselves.
(ii) There was no significant response to the other fertilizer combinations.

IMPROVED RICE SEED PRODUCTION AND DISTRIBUTION IN CEYLON

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ICA Consultant

I. Introduction

The scheme for production of pure rice seed was prepared by the author after a brief visit to a few research and seed production farms in Ceylon. This report is very similar to the one previously prepared by Mr. A.S. Ranatunga, in which he presented the essential steps for a sound and workable plan. The present scheme, however, goes into greater details by indicating some operational problems and suggesting possible lines of approach for future endeavour.

II. Objectives

Unless improved varieties are widely grown on a commercial scale, the time and money expended on a variety improvement scheme is not justified. It is essential that provision be made for an organized system of maintenance of variety purity, seed increase and seed distribution if the rewards of variety improvement research are to be realized. A scheme of improved seed production and distribution is the necessary link between research and commercial production.

Many new rice varieties have been introduced or developed in Ceylon that are superior to local varieties in yield and other characteristics. However, it is estimated that perhaps not more than 15 per cent of the 1,200,000 acres are presently being planted to these improved varieties.

Two conditions are necessary to achieve wide acceptance of improved varieties :

1. A regular available supply of pure seed of the improved varieties at locations accessible to cultivators.
2. Adequate provision for an adult educational program such as an agricultural extension service to demonstrate to cultivators the superiority of improved varieties.

It is not possible to place a priority on the above two conditions necessary for the introduction of new varieties, as one without the other will not achieve results.

It should be emphasized that pure seed of improved varieties may not achieve the desired result of increased production unless other factors of good production are employed. It should be kept in mind that pure seed of improved varieties is only one of the many factors that can be used to increase production. Highest production can be attained only by using all the known improved production methods. The objective is increased production.

III. Choice of Improved Rice Varieties

It can readily be appreciated that any scheme devised for maintaining variety purity and promoting seed multiplication is made more difficult as the number of varieties increase. The work of the plant breeder in maintaining foundation seed becomes burdensome and the land area involved becomes greater when many

varieties are involved. The burden placed on government seed farms when several varieties are to be increased becomes greater from the standpoint of field production, isolation, seed cleaning, storage, and distribution. The greatest difficulty will probably be encountered when seed multiplication is attempted on cultivators' fields if a large number of varieties are maintained.

At the present time in Ceylon there are nearly 40 improved varieties of rice that are recommended for commercial production. Some are being grown much more widely than others. Perhaps ten of these 40 varieties constitute the bulk of the acreage devoted to improved varieties. In addition there are probably several hundred local varieties of rice which accounts for nearly 80 to 85 per cent of the present area according to estimates.

Before launching upon a scheme of pure seed production it is strongly recommended that serious consideration be given to reducing the number of rice varieties to be included in a pure seed production scheme. The selection of these varieties should be by a committee representing the Department of Agriculture, Agricultural College, Department of Commerce and Trade, village extension workers, and farmers.

It is recognized that varieties must be selected to satisfy such requirements as maturity period, altitude, rainfall and soil variations. Lesser attention in selection of varieties should be given to the personal "whims", superstition and dietary habits of cultivators. A deficit rice producing country cannot afford the luxury of satisfying the consumer demand of all groups at the expense of yield or calories produced per acre.

IV. Foundation Seed Production

Maintaining a source of pure seed of the varieties intended for seed production is the first step in a sound pure seed production scheme. This is the foundation seed upon which the purity of all subsequent increase depends. This should be the function of well trained plant breeders on the research stations. It is obvious that this phase of the scheme requires extreme close supervision to avoid variety mixtures through mechanical processes or genetic changes due to chance cross pollination or mutations. This phase of the program should never be entrusted to field assistants who are not thoroughly familiar with the variety characteristics of the material being maintained.

Plant breeders in Ceylon are using a system to maintain the purity of foundation seed that differs from the method used in the United States. The steps used in Ceylon are as follows:

1. Grow four 3-row plots.
2. Bag one plant in center row of each 3-row plot.
3. Save the seed from the four bagged plants for repeating the four 3-row plots the following year.
4. Bulked seed of the four 3-row plots becomes the foundation seed.

This is a continuous process whereby seed of 12 rows are bulked for foundation seed and seed retained for future rows from the four bagged plants. The bulked seed from the 12-rows is referred to in Ceylon as S-2 seed. This S-1 seed is further increased

on research stations and produces S-2 seed which is further increased on government seed farms to produce "registered" seed which it is anticipated under the proposed new scheme will be planted by selected private seed farmers for the production of certified seed. This certified seed is intended for distribution to cultivators for the production of commercial crops.

The scheme of the proposed seed plan in Ceylon consists of the following steps:

1. Maintenance of breeders' stock	–	Plant breeder
2. S-1 seed production	–	Research station
3. S-2 seed production	–	Research station
4. Registered seed production	–	Government seed farm
5. Certified seed production	–	Selected private seed farmers.

The system used in the United States to produce foundation seed, which corresponds to the S-1 seed produced in Ceylon, is to make a mass selection of panicles in a certified seed fields for growing in panicle rows. (One hundred to 500 panicles selections are made at random depending on how frequently the variety is purified or how much foundation seed is required.) During the growing season the off-type rows are noted and discarded. All rows remaining that are uniform to type are harvested and threshed in bulk to produce the foundation seed. Briefly this system consists of the following steps:

1. Make mass selection of panicles from certified seed field.
2. Plant seed of each panicle in separate rows.
3. Discard off-type rows.
4. Harvest and thresh rows uniform to type in bulk for foundation seed stock.

Either method is acceptable, and both will produce foundation seed of acceptable quality if properly supervised. The mass selection method provides a broader genetic base. Maintenance of seed stocks on the basis of selecting four plants each year, as practised in Ceylon, provides the possibility of rapid genetic change in the seed stock of genes that are not phenotypically observable. If only one of the four plants selected and bagged each year differs from the other three in such characters as disease resistance or quality, both of which could easily be overlooked at bagging time, the foundation stock could differ by 25 per cent in one season.

Indigenous variety improvement. One of the merits of the mass selection methods which should be pointed out, aside from its use as a method for producing foundation seed, is its adaptability to improving local varieties. This may not be accepted by all plant breeders as a sound method of variety improvement, but it has a distinct practical application. Mass selection of panicles from a local variety of unknown genetic origin when grown in panicle rows followed by discarding the most obvious "off-types" can result in a rapid improvement from the standpoint of uniformity in maturity date, grain type, plant height, straw strength and grain color.

It is conceivable that the local varieties may possess some very desirable local adaptations due to many years of natural

selection. By mass selection and discarding the most undesirable characteristics, the varieties can be greatly improved without losing their desirable characteristics if a broad base for selection is used.

V. Government Seed Production Farms

As previously pointed out, under the present system, the government seed production farms take the S-2 that is produced on the research stations for increasing and producing the registered seed which is sold to cultivators through the regional extension officer and the local extension advisors. Unfortunately, time permitted visiting only four of the government operated farms that are increasing S-2 seed and producing registered seed. The comments given are based on the observations and impressions reached from these few farms which it is believed are quite representative of the seed farms throughout Ceylon.

Size of seed farms. It is believed the seed farms are larger than can properly be farmed and supervised for the production of high quality seed. It was quite obvious that these large areas were originally intended to be farmed, at least partially, by mechanized equipment. In certain instances the mechanized equipment was not made available. In other cases the intended equipment is not adapted to the conditions under which it should be used. In other cases the equipment was not in repair and suitable for use. Mechanization cannot be used effectively unless all operations are mechanized, and each operation must be "geared" together to work as a complete operational unit. A breakdown in any one operation creates a limiting factor governing the entire operation. When the limiting factor of production is the labour supply for a critical operation, there is little or no justification in exceeding the size of operation beyond which the available labour can perform. Large acreages become difficult to supervise, and the operations may become "sloppy" at the expense of saving time.

The seed farms visited are attempting rice seed production on areas ranging from 100 to 500 acres. One of the most serious problems encountered is the availability of labour for critical operations such as sowing and harvesting, when it becomes necessary to compete for labour for the same operations in the surrounding community. This labour scarcity not only retards the operations on the seed farm, but may also retard production of cultivators in the adjoining area who depend on the same labour.

It is believed that a larger number of smaller farms well staffed and supervised would result in more economical production from which a higher percentage of the crop would be suitable for seed. On some of the present seed farms, 20 to 30 per cent of the production is unsuitable for seed purposes. The requirements for registered seed from the seed farms may be reduced in the new seed production scheme if another step in seed increase by selected private seed farmers is put into operation. The number of government operated seed farms should conform to the requirements of selected private seed farmers who will produce certified seed.

The seed produced on the government seed farms should be governed by standards of production and seed standards in the same manner as seed produced by the selected private seed farmers. The standards

should include such factors as (1) suitability of land, (2) isolation, (3) objectionable weeds, (4) freedom from serious diseases, (5) variety mixtures, and (6) suitable processing equipment. Seed standards should be met on such items as (1) germination, (2) variety mixtures, (3) test weight, (4) inert material, and (5) weed seeds. The rice fields on government seed farms should be inspected before harvest to satisfy compliance with the standards, and the seed inspected after threshing and drying to determine compliance with predetermined seed standards.

Storage. One of the problems that seemed uppermost on seed production in Ceylon was the matter of storage. The nature of the problem is primarily one of insect damage, but spoilage and loss of seed due to molding, rodent damage and pilferage should not be overlooked. The merits of bulk storage in modern steel bins has not been determined in Ceylon. However, it is recognized such bins would have many advantages such as ease of fumigation and proofing against rodent damage. But, it should also be pointed out that bulk storage in such bins may be harzardous if rice of high moisture is stored. Bulk bins are also expensive.

The practice now followed on government seed farms is to store the rice in sacks in godowns. The godowns visited on the tour were well constructed and quite adequate. The only criticism offered would be that the construction was such that adequate aeration was not possible. Ventilators on the sides and ends of the godown to allow for a cross current of air to pass through the structure is highly desirable. The construction should be such that these ventilators may be closed in case fumigation is required.

The first consideration in proper storage should be the moisture content of the grain. Stored grain of high moisture content is conducive to insect damage. Storage of grain of high moisture content may heat and/or mold, both of which are detrimental to germination. Rice for seed should be 12 per cent or below in moisture if stored in sacks and not over 14 per cent moisture if stored in bulk. There is no moisture testing equipment at the present time in Ceylon. The dryness necessary for storage is now based on experience from feel and observation of the grain. Such a practice probably accounts for much rice being stored with excessive moisture resulting in loss of germination and high weevil damage. It is recommended that moisture testing equipment be acquired for testing rice to be stored for seed.

It is recommended that rice seed, produced both on the government seed farms and selected private seed farms, be stored in sacks. The construction for sack storage is less expensive, conditions can be made ideal for keeping quality and less expensive handling equipment is needed. Sacking would eventually be required for distribution anyway, since no adequate bulk hauling is available and farmers have no convenient way to store bulk seed rice to prevent contamination. Labeling of pure seed in sacks is quite simple, while labeling and keeping the identity of bulk lots is more difficult.

Seed treatment. The use of grain protectants to control insect damage is possible. Chemicals for this purpose have been

found to be quite effective under many conditions, and their use does not render the rice unfit for human food, in case it is not used for seed.

One such material used in the United States and reported to be effective is known by the trade name of WeevlDoom "60". The chemical composition of this material is:

Active ingredients:

Technical piperonyl butoxide	– 60%
Pyrenthrine	– 6%
Inert	– 34%

The directions are to mix 1 gallon of WeevlDoom "60" with 29 gallons of water and spray the grain uniformly with this mixture, at the rate of 5 gallons per 1000 bushels of grain. The cost of treatment is reported to be 1.2 cents per bushels (about Rs.0.06). Effectiveness of this protectant might well be studied in Ceylon. This material and literature is available from the Mid-Western Spray-Chemical Company, Inc., Mission, Kansas, U.S.A.

An important step in keeping grain insect free is to practice sanitation around the storage facilities. Discard all refuse grain and used sacks, and spray the cleaned premises with an insecticide before the storage season.

VI. Seed Increase on Selected Private Seed Farms

The production of pure seed by selected private seed farms is a new phase or step in the proposed new seed production scheme. This is the crucial step in the proposed scheme and admittedly the most difficult to implement. However, it is an extremely important step and essential if pure seed production is attained on a scale to make an effective impact on the commercial production of improved rice varieties in Ceylon.

Selection of private seed farms. The proposed seed plan envisages selection of an area of about 100 acres in size in which all the cultivators in this area become seed growers. It is believed that incentives for producing pure seed will be sufficient through seed rice price subsidy, free fertilizer and other commodities to insure complete cooperation of the farmers in the selected areas.

It should be pointed out that such a proposal as suggested, which includes all cultivators in an area as pure seed producers, has certain disadvantages. One of the most serious would be the necessity of including farmers irrespective of their interest in pure seed production. In other cases farmers may not understand the fundamentals of pure seed production and the quality of seed they produce may be below standard. It can be expected that some farmers within a selected area will only be interested in the subsidy feature of the program with little thought or interest in pure seed production. In still other cases a selected area may contain farmers that farm very poorly and their production will not be a credit to pure seed. Unusual climatic conditions, scarcity of water or other conditions unfavourable for production on a confined area could materially retard the seed production and limit the seed supply for a district in case of failure or near failure of a crop.

The selection of a concentrated seed producing area involving many growers has certain advantage that may overshadow

the difficulties encountered on widely scattered small tracts of individual pure seed producers. Selected areas of considerable size may greatly simplify the supervision and inspection so necessary in the production of pure seed. Storage and processing are greatly simplified. The conduct of educational activities so essential in a pure seed production plan is much easier in concentrated areas.

It is emphasized that caution should be exercised in the selection of a pure seed producing area involving several cooperative farmers. Some of the questions that should be answered in the selection are as follows:

1. Will there be a demand for the seed when produced?
2. Is the area clearly defined by natural boundaries?
3. Is the area served with adequate educational facilities such as furnished by the Agricultural Extension Service to advise on all phases of improved agricultural practices?
4. Does the area have isolated threshing and cleaning facilities?
5. Is the area in close proximity with intended processing and storage facilities?
6. Is the area accessible for proper distribution of the seed produced and accessible for inspection and educational activities?
7. Is the area reasonably free of production hazards to minimize the possibility of crop loss?

It is suggested that the 100 acre tracts referred to in the proposed seed plan *not* be adhered to too closely. A tract of 25 acres or less meeting the requirements as listed above would be much more satisfactory than a larger tract that does not meet these requirements. Other factors will also influence the size of the seed producing areas such as (1) available registered seed supply, and (2) the demand requirements for seed. The initial production could well start with quite small areas and expand, as the program develops and the demand for pure seed increases.

Production requirements. An important point is to keep within practical limits when formulating the production requirements and setting standards of production. A pure seed program will not succeed if the standards are set so high that they are impractical to attain. It is better to error on the side of setting the standards too low rather than setting them too high. The standards can be raised as experience and demand warrant. Standards set too high will kill the program.

Some of the points to keep in mind when determining the production requirements for pure seed are:

1. Natural boundaries of the production area to make possible a clear destination between seed producing and commercial crop producing areas.
2. Previous crop on the land and the possibility of mixtures through volunteer plants.
3. Presence of noxious weed and pests.
4. Location of the area in relation to water supply and water flow to avoid mixtures due to seed floating.
5. The availability of isolated threshing floors and threshing equipment suitable for thorough cleaning.

These conditions should all be thoroughly investigated before selecting a seed producing area. Periodic supervision will be required to educate the cultivators to avoid all sources of seed contamination. Supervision and inspection is especially necessary at the harvesting season. The authorized inspector should have the authority to discard any parcel of a field or a cultivators' crop that fails to meet the production requirements during the growing season or before the harvesting time.

Field inspection for variety purity should be made soon after full heading. A maximum variety mixture of one plant per square yard is suggested as a standard to begin with. A maximum of one red rice plant in 25 square yard is suggested. In case of red rice varieties one white rice plant in 25 square yard is suggested as the maximum tolerance.

Standards for seed purity. In addition to standards of field purity there should be established standards for seed purity. These determinations should be made on rice after all cleaning and processing has been completed. This constitutes the final test upon which the certification is made provided all previous requirements have been met.

The suggested seed standards are as follows:

Germination (minimum)	– 80%
Purity (minimum)	– 95%
Inert matter (maximum)	– 5%
Varieties of other types (maximum)	– 5 seeds per 100 grams
Red rice (maximum)	– 1 seed per 100 grams

Seed testing laboratory. To make possible the testing of seed purity and germination it is essential that a seed testing laboratory equipped for this purpose be established in Ceylon. The operation of the seed testing laboratory should be the responsibility of the Department of Agriculture. Such a laboratory in the Department of Agriculture would be useful for other purposes such as: (1) grading rice for loan purposes, (2) inspection of rice imports for compliance with specifications, (3) determination of rice quality for purposes of establishing price differentials to be paid to farmers, and (4) for experimental purposes such as determining the efficiency of various storage structures.

The following list of equipment is suggested to equip a seed testing laboratory:

	Approximate price (FOB U.S.A.) $
Moisture meter	450.00
Drying oven	350.00
Gram scales (100 gram capacity)	200.00
Torsion balance scale	200.00
Bulk storage grain trier (63 inch)	30.00

Sack trier	6.00
Grain dockage sieves (rice)	40.00
McGill miller	135.00
Dockage tester	190.00
Bushel weight tester	150.00
Grain sample cans (per hundred)	35.00
Grain pans (per dozen)	30.00
Sample divider	120.00
Bates laboratory aspirator	300.00
Seed germinator	120.00
Seed forceps (per dozen)	10.00
Purity work board	20.00
Office clipper cleaner	110.00
Grain thermometer (per dozen)	30.00

All the above equipment is available from the Seedburo Equipment Company, 618 West Jackson Blvd., Chicago 6, Illinois, U.S.A.

Tagging. After seed is inspected in the laboratory, it should be tagged to show the purity analysis and germination as well as the variety designation. A sample of such a tag as shown below is generally used and attached to each sack.

Kind of seed__________ Variety__________
Germination %__________ Purity %__________
Inert matter %__________ Weed seed %__________
Grower____________________
Year__________ Town__________

On the back side of the tag is bold printed such notation as "Government Certified Pure Seed". Such tags are usually in attractive color such as blue, green, red or yellow. Different coloured tags can be used to indicate the seed produced either by government seed farms or by selected private seed growers.

It is suggested that recognization should be given to the selected private seed growers in the form of a membership card. Such recognization often gives the grower a feeling of being a part of the scheme (which of course he is) and greatly increase his interest in the production of pure seed. The following type of card in an attractive colour, that he may carry or display in his home, is suggested.

Membership Card

CEYLON PURE RICE SEED ASSOCIATION

This is to certify that:

Name____________________

Address____________________

is a producer of pure rice seed for increasing rice production in Ceylon.

____

Secretary of Agriculture

Seed distribution. As has previously been stated, the objective of a pure seed production scheme is to get this seed used by farmers for production for a commercial crop. Unless the necessary steps are taken to educate the farmers on the advantages to them by sowing pure seed, the objective is not likely to be attained. In addition to the education required to convince farmers of the merits of pure seed, the supply of pure seed must be made easily and regularly available from the standpoint of both location and price.

Extension activities. The job of educating the mass of farmers on the value of pure seed will require a large staff of well trained agricultural extension workers. This staff must themselves be thoroughly convinced and enthusiastic advocates of pure seed and be capable through the various extension media to convince the farmers of the favourable merits of pure seed. The media available to extension workers for teaching are field demonstrations, lectures, publications, and personal contacts.

The greatest incentive toward influencing farmers to accept a new practice is the profit motive. It can be demonstrated by field plots that pure seed of improved varieties are superior in yield. There should be initiated a scheme by the Ceylon Government to reward the growers who produce commercial rice of pure varieties and superior quality. If the government price is fixed with little or no regard for quality and purity of variety, the incentive for producing rice of pure varieties is materially reduced. A reduction in the government purchase price for rice of mixed varieties would quickly bring to the attention of farmers the value of pure seed.

VII. Personnel Training

The importance of a pure rice seed program in Ceylon would seem to justify the expenditure involved in sending one or more persons to study pure seed production and seed certification procedures in other countries. It is suggested that such countries as Japan, Philippines, Formosa, and United States be visited and their pure seed production and distribution program be studied.

The pure seed production and distribution scheme as proposed for Ceylon is similar in almost all respects to the scheme now in operation in Formosa. The Formosa scheme has worked very well under the conditions of that country, and has resulted in a very high percentage of the acreage being planted to improved varieties. The plan as used in the Philippines is patterned largely after the system used in the United States with certain modifications to fit Philippines conditions. The plan used in Japan is quite different from other countries, but is very successful under their system of cooperative production and distribution.

The pure rice seed production and distribution plan in the four leading rice states of the United States differs in certain respects, since each state operates under the seed certification plan of the respective state. However, each state has an effective seed production scheme.

Study in the United States would afford an opportunity to make a thorough study of laboratory technique and equipment, and how it is used. Few, if any other

countries except possibly Europe, would afford this opportunity. The Philippines has at present a partially equipped seed testing laboratory which is the only one believed in operation in Asia.

Special courses in seed testing technique and use of seed testing equipment are offered at Mississippi State College, Mississippi, U.S.A. The training is available to foreign students, and more complete information can be had by writing directly to this College.

VIII. Summary

After two weeks of study in Ceylon, it is quite evident that an improved scheme of pure seed production should be inaugurated. The recently prepared report by Mr. A.S. Ranatunga, in which a scheme for pure seed production is proposed, contains the basic essentials for a sound seed production program.

Foundation seed stock should be maintained by well trained plant breeders, who can give their personal attention to the selection of pure seed stocks.

On the basis of the limited number of government seed farms visited, rice seed production is not efficient, either from the standpoint of quality of seed produced or the quantity. No organized and systematic plan was in evidence for effective distribution of seed produced on government seed farms. Smaller farms with a greater concentration of production and more thorough supervision is suggested.

The advantages and disadvantages are pointed out of concentrating pure seed production in compact blocks of selected private seed farms. This phase of the pure seed production scheme is extremely important but perhaps the most difficult to implement. It is believed that starting with only a very small number of selected private seed farm areas of small size to facilitate concentration of effort will result in greater assurance of success.

A seed laboratory should be established for the purpose of testing seed for compliance with germination and purity standards. Such a laboratory would also be useful for experimental studies on quality as effected by storage, agronomic, and climatic factors.

An adequate agricultural extension service is required to educate farmers on the value of pure seed and to demonstrate improved production practices if the most efficient use of improved varieties is expected.

Personnel training in specified foreign countries is suggested. Such training will acquaint trainees on pure seed production and seed testing practices in other countries and afford an opportunity to select features of each country's plan that may be adapted to Ceylon.

STORAGE LOSS OF PADDY DUE TO SITOTROGA CEREALELLA AND ITS CONTROL

H.E. Fernando*

I. Introduction

In recent years there has been accumulated a considerable amount of information on storage losses of agricultural products due to pests (Parkin 1956), and the general food shortage of the world, together with the need for good seed material, has stimulated much interest in this field of study. A few examples of such storage losses will serve to illustrate the purpose. In 1948 to 1949 a Working Party of the United Nations observed very marked storege losses to such crops as maize, rice and pulses in Latin America, ranging from 25 per cent in El Salvador, 30 per cent in Nicaragua, 45 per cent in Costa Rica and 50 per cent in Honduras. Eden (1953) estimated that 50 per cent of the stored maize in the State of Alabama in the U.S.A. was destroyed by insects. Harris (1950) has observed a loss of 91 per cent of bagged seed maize due to insects in Uganda, while Cockbill (1953) recorded a 28.4 per cent loss of maize stored for five months in Southern Rhodesia.

The present investigation, however, covers details of a smallscale survey of the damage done to paddy in storage by the grain moth *Sitotroga cerealella*, and the use of chemical methods to control it.

II. Field Infestation

The extent of *S. cerealella* infestation of paddy in the field prior to harvesting or threshing is an important consideration in assessing the need for prestorage treatments. Paddy was therefore collected from the field or from the threshing floor. Three varieties of paddy were thus collected from three different locations, and placed in glass jars. The mouths of the jars were tightly closed to prevent infestation from outside. The grain was removed at monthly intervals for assessing damage. Three half ounce samples of paddy were removed each time from each jar, and the good and damaged grains counted. Table 1 gives the results of these observations taken over a period of 8 months. It clearly indicates that infestation by *S. cerealella* is of great importance from the standpoint of enforcing prestorage disinfection practices.

III. Varietal Differences

An experiment was carried out to test the susceptibility of different varieties of paddy to *S. cerealella* attack and also to assess the efficacy of BHC (benzene hexachloride) dust in the control of this pest. Paddy of two varieties (Mas 24 and Ptb 16) were collected from Nalanda and Hingurakgoda respectively. Three pounds and five ounces of each variety were placed in loose muslin bags. Two bags of each veriety were treated with BHC 0.65 per cent dust at the rate of 1 oz., 2 ozs. and 4 ozs. per bushel prior to bagging. Three half ounce samples were removed from each bag at monthly intervals for counting good and damaged grains. The results are presented in Table 2. The

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rate of attack is much higher with Mas 24 than with Ptb 16 in both the treated and the untreated samples.

IV. Chemical Methods of Control

While the data presented in Table 2 indicate a fair measure of control of *S. cerealella* in its attack on stored paddy with BHC dust, it was felt that some of the newer organic insecticides might prove to be effective than this chemical. The effectiveness of gamma BHC was therefore compared with that of Pyrenone and Malathion dust. Pyrenone dust contains 0.05 % pyrethrins synergized with 0.8 % piperonyl butoxide. This preparation has been effective in storage pest control in some parts of the world. Malathion was selected for its low toxicity. These investigations were carried out in grain storages at Hingurakgoda and Okampitiya. The treatments at Hingurakgoda consisted of mixing of dusts of the 3 insecticides with the grain at 2 dosages, a combination of grain treatment with a pyrenone spray (at a higher concentration for spraying bags), or spraying bags only. At Okampitiya a similar trial was conducted, except that, in the case of combined grain treatment and bag spraying, the bag received the same chemical treatment as the grain, only in the emulsion form.

The Hingurakgoda trial commenced with freshly harvested grain, while the Okampitiya trial started with grain already in storage for 2 months. Two and a half bushels of grain were used for each treatment which was duplicated. Grain was treated only once prior to storage, while bag spraying was done at monthly intervals. Sampling of grain for study of pest infestation was done monthly. One cigarette tin-full of grain was taken from each bag and this consisted of 1/3 from the upper surface of the grain, 1/3 from a side of the bag and 1/3 fron about 8 inches below the surface of the grain. Each sample was thoroughly mixed, and five portions one hundred grains each were separated from each sample for counting good and damaged grains. The results of these two trials are presented in Tables 3 and 4. Seed germination was not affected by any of the treatments.

V. Discussion of Results

The high rate of infestation of paddy in the field by *S. cerealella* emphasizes the need for prestorage treatment. This could be achieved by fumigation or by thorough sundrying and adding insecticidal dusts prior to storage. Facilities for fumigation in Ceylon are wanting at present, and in any case the effects of fumigation are not as prolonged as those of insecticidal additives.

Varietal susceptibilities of paddy to *S. cerealella* have been apparent in this study. The basis for this difference is however not clear, but it should be an important consideration in deciding the value of a new selection.

The two insecticidal trials on *S. cerealella* control, in which synergized pyrethrins and malathion preparations were compared with BHC dusts, have yielded valuable results. Synergized pyrethrin dust was inferior to both gamma BHC and malathion dust. Treatment with malathion dust alone gave excellent results. BHC dust was slightly more effective at Okampitiya than at Hingurakgoda. A combined bag and

grain treatment gave slightly better results than either grain or bag treated alone. Bag treatment alone gave satisfactory results, but this was more marked at Hingurakgoda with freshly harvested grain than at Okampitiya where the grain used had been stored for two months.

On the basis of these studies, treatment of seed paddy with a 0.4 % malathion dust at the rate of 2.25 ozs. per bushel prior to storage can be recommended. When bags alone are sprayed, 2 fluid ounces of a 50 % malathion emulsifiable concentrate in one gallon of water for monthly spraying in the store can also be recommended for protecting consumption grain.

VI. Acknowledgements

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Table 1. Damage to paddy caused by *Sitotroga cerealella* infestation occuring in the field and threshing floor before storage.

Variety of paddy	Date of collection	Place of collection	Source of paddy	Percentage of Infestation							
				March	April	May	June	July	August	September	October
Ptb 16	14.2.56	Bathalagoda	from field	0.13	0.54	1.9	3.8	5.5	6.1	7.8	9.9
Murungakayan	29.2.56	Bathalagoda	from field	0.0	0.4	1.1	2.1	2.8	4.0	5.0	6.6
Ptb 16	16.3.56	Hingurakgoda	from field	–	0.0	0.4	1.1	1.9	2.5	4.6	7.9
Mas M 24	16.3.56	Hingurakgoda	from field	–	0.0	0.0	0.0	0.0	0.0	0.0	0.3
Murungakayan	16.3.56	Hingurakgoda	from field	–	1.8	2.0	3.1	4.5	5.7	8.5	10.8
Murungakayan	16.3.56	Nalanda	from field	–	0.9	2.6	4.6	5.4	7.4	8.5	10.2
Murungakayan	18.3.56	Bathalagoda	from threshing floor	–	0.7	1.3	2.7	4.5	6.0	7.3	9.1

Table 2. Difference in susceptibility to two varieties of paddy in storage to attack by *Sitotroga cerealella*.

Period of observation after treatment	Per cent grain damaged by *Sitotroga cerealella* under various treatments							
	1 oz. 0.65 % BHC dust per bushel		2 ozs. 0.65 % BHC dust per bushel		4 ozs. 0.65 % BHC dust per bushel		Untreated Checks	
	Mas M24	Ptb 16	Mas M24	Ptb 16	Mas M24	Ptb 16	Mas M24	Ptb 16
1 month	0	0	0	0	0	0	0	0
2 months	1.25	0.6	1.3	0.7	1.35	0.45	1.2	0.55
3 months	2.7	0.65	1.45	0.6	1.0	0.6	6.55	1.85
4 months	3.2	1.05	1.7	0.65	1.1	0.55	12.9	3.7
5 months	4.2	1.9	2.25	0.65	2.6	0.7	20.6	5.2
6 months	7.5	3.25	5.0	1.35	3.75	0.9	31.3	8.0

Table 3. Effect of paddy treatment on the control of *Sitotroga cerealella* at Hingurakgoda

Type of treatment	Insecticide, formulation and dosage applied	Percent grain damaged by pests: After 3 months	Percent grain damaged by pests: After 6 months
Only grain mixed with insecticide	Malathion 0.4% dust, 4.5 ozs. per bushel	0.20	0.80
	Malathion 0.4% dust, 2.25 ozs. per bushel	0.12	0.20
	Pyrenone(1) dust, 3.2 ozs. per bushel	3.49	10.38
	Pyrenone dust, 1.6 ozs. per bushel	10.3	12.95
	Gamma BHC 0.6% dust, 4 ozs. per bushel	1.16	4.90
	Gamma BHC 0.6% dust, 2 ozs. per bushel	5.5	7.57
Both grain mixed and bags sprayed	Malathion 0.4% dust, 4.5 ozs. per bushel	.0	0.74
	(3) Pyrenone high conc. for bag spraying monthly	0.0	0.74
	Malathion 0.4% dust, 2.25 ozs. per bushel	0.	
	(3) Pyrenone high conc. for bag spraying monthly	0.1	0.64
	Pyrenone dust 3.2 ozs. per bushel (3) pyrenone high conc. for bag spraying monthly	0.2	0.62
	Pyrenone dust 1.6 ozs. per bushel (3) Pyrenone high conc. for bag spraying monthly	0.2	0.71
	Gamma BHC 0.65% dust 4 ozs. per bushel (3) Pyrenone high conc. for bag spraying monthly	0.31	0.75
	Gamma BHC 0.65% dust 2 ozs. per bushel (3) Pyrenone high conc. for bag spraying monthly	0.82	2.22
Only bags sprayed	Malathion 50% EC 2 fl.oz per gallon water – light spray monthly	0.0	2.43
	Malathion 50% EC 1 fl.oz. per gallon water – light spray monthly	0.3	2.19
	Pyrenone EC 5 fl.oz. per gallon water – light spray monthly	1.0	7.6
	Pyrenone EC 2 fl.oz. per gallon water – light spray monthly	3.9	10.3
	Gamma BHC 20% EC 2 fl.oz. per gallon water – light spray monthly	2.17	3.47
	Gamma BHC 20% EC 1 fl.oz. per gallon water – light spray monthly	2.42	5.11
Untreated checks		5.62	11.89
		5.04	14.05
		7.65	16.29

Table 4. Effect of paddy treatment on the control of *Sitotroga cerealella* at Okkampitiya

Type of treatment	Insecticide, formulation and dosage applied	Percent grain damaged by pests	
		After 3 months	After 6 months
Only grain mixed with insecticide	Malathion 0.4% dust, 4.5 ozs. per bushel	1.55	1.7
	Malathion 0.4% dust, 22.5 ozs. per bushel	1.7	2.72
	Pyrenone(1) dust, 3.2 ozs. per bushel	2.95	5.0
	Pyrenone dust, 1.6 ozs. per bushel	3.45	5.55
	Gamma BHC 0.65% dust, 4 ozs. per bushel	2.20	2.9
	Gamma BHC 0.65% dust, 2 ozs. per bushel	2.65	4.45
Both bags sprayed and grain mixed	Malathion 0.4% dust, 4.5 ozs. per bushel (3) bags sprayed with Malathion emulsion(2)	1.15	2.05
	Malathion 0.4% dust, 2.25 ozs. per bushel (3) bags sprayed with Malathion emulsion	1.75	2.40
	Pyrenone dust 3.2 ozs. per bushel (3) bags sprayed with Pyrenone emulsion(4)	2.2	2.65
	Pyrenone 0.4% dust, 1.6 ozs. per bushel (3) bags sprayed with Pyrenone emulsion	2.13	2.75
	Gamma BHC 0.65% dust, 4 ozs. per bushel (3) bags sprayed with gamma BHC emulsion	1.8	2.05
	Gamma BHC 0.65% dust, 2 ozs. per bushel (3) bags sprayed with gamma BHC emulsion	2.85	4.1
Only bags sprayed	Bags sprayed with Malathion emulsion	3.35	3.65
	Bags sprayed with pyrenone emulsion	5.5	6.85
	Bags sprayed with gamma BHC emulsion	5.05	5.95
Untreated checks		6.9	10.05

(1) Pyrenone dust = 0.8% piperonyl butoxide and 0.05% pyrethrins

(2) Malathion emulsion spray = 2 fl.oz. 50% malathion E.C. in 1 gallon water

(3) Pyrenone emulsion spray = 5 fl.oz. of preparation, containing 7.5% Pyrethrins and 75% Piperronyl butoxide, mixed in 1 gallon water

(4) BHC emulsion spray = 2 fl.oz of 20% E.C. in 1 gallon water

THE FIRST PILOT RICE MILL IN LIBERIA

M. Manni[1]
and
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I. Background Information

An example of an international approach to problems of rice processing is the installation of a small rice processing pilot plant in Liberia between 1952 and 1953, with FAO technical assistance. In Liberia practically all rice planted is of upland varieties and grown on small plots, which are previously cleared of bush by hand during the dry season in January, February and March. Seed is broadcast between stumps and logs, and scratched in during the months of May, June and July. Harvesting begins in September and lasts through December. Each stalk is cut with a small knife about 8 inches below the base of the head, tied into bundles and left to dry on the stumps and logs in the field. Later these bundles are transported to "kitchens", consisting of a loft in a thatched roof building, above a smoldering fire. These bundles remain there until they are home-pounded for commercial use. This storage practice seems to be adequate for local needs and in maintaining moisture content low enough to minimize deterioration and insect infestation. When needed, the bundles are removed from the loft and threshed by spreading them on the ground and flailing them with sticks and tramping on them by many feet. Under such circumstances, it is difficult to keep the paddy and later pounded rice free from small pebbles.

Rice processing is mainly done by hand-pounding. The equipment used consists of a hollowed-out log and a rounded pole operated by a woman in a vertical action. Small amounts of paddy are placed in the mortar and then pounded. As the husks are dislodged and the mixture is removed, the husked rice and husks are separated by means of a mat-type basket. Any paddy remaining is returned to the mortar for additional pounding. The husked rice is then fit for commercial sale, despite the fact that the product still contains a certain percentage of paddy and varying amounts of pebbles. However, before rice is considered suitable for cooking, it is pounded again by the consumer, during which action the remaining husks are removed, along with additional bran layers. In a subsequent process of rinsing the small pebbles are picked out.

In Liberia parboiling is not in general practice, the bulk of rice being marketed in the raw state. However, during the early harvesting season when the new grain is high in moisture content, either parboiling or parching is resorted to as a means of reducing water content. The general practice of parboiling is as follows: A small iron pot is partially filled with paddy, and water is added to about one-third of the depth. Then the top is covered and the pot placed over a fire, until all water has been steamed off. Afterwards,

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the contents are spread out on bamboo mats exposed to sun shine until the grain is dry enough for pounding. Parching consists of filling the vessel with paddy to one-third of its capacity, and heating it over a fire. The contents are frequently stirred until fit for processing.

Customarily, paddy is processed on the farms or in the villages before being transported to marketing centers for sale. The traders either sell the rice immediately in consuming areas or store it for higher prices later on.

II. Home Pounding—A Limiting Factor in Rice Cultivation

Since home pounding is the general practice in Liberia, the rice cultivation per farm has been kept small so that farm women could pound the produce at home. As a result, between 8 and 12 thousand tons of rice have to be imported annually to meet the market demands. This has promoted the government to try to erect modern rice mills so that rice acreage could be expanded and production increased.

III. FAO Technical Assistance

The Government of the Republic of Liberia therefore requested FAO to provide the services of a rice processing expert to advise and assist in the estalishment of a small rice processing pilot plant. The expert served in the country from 30 May 1952 to 4 March 1954.

The expert focussed his attention on the following points:

(1) choice of a site,
(2) selection of equipment, and
(3) structural design.

In choosing a site for the mill, the following factors were taken into consideration:

(a) Paddy supplies
(b) Transportation facilities
(c) Electric power
(d) Repair shop
(e) Labour
(f) Supervision.

After several investigations, the government experiment station at Suakoko was finally selected.

In the selection of suitable equipment for the mill, the following points were considered:

(a) Due to the methods employed in threshing, much chaff and dirt and many stones are contained in the paddy. It was deemed necessary to include cleaning equipment in the set-up.

(b) Since the local people are accustomed to undermilled rice, it was decided to limit scouring to a minimum and to conserve as much of the nutrients as possible.

(c) Since grading is not important in Liberia, it was decided that all recoverable rice, whole and broken, would be saved and packed together.

On the basis of these considerations, it was believed that the standard type of self-contained milling units would not be suitable for local conditions, and that the following pieces of equipment were selected:

A thresher. A hand-powered thresher unit to be placed outside the mill to thresh

bundles, thereby speeding up the supply of paddy.

A cleaner. A conventional type of cleaner, including 3-sieves and discharging into a cyclone collector.

A stoner. An inclined vibrating deck, based upon airfloat separation through variances in specific weights.

A husker - aspirator. A rubber belt type of husker, containing an internal aspirating box connected to a fan, discharging into a cyclone collector, for separation of husks from husked rice.

A scourer. A metal ribbed cylinder revolving against an adjustable blade, whereby the kernels are rubbed against each other. A fan is included, blasting into a cyclone collector.

A classifier. A 1-sieve vibrating screen, clothed with perforated metal.

Logging. Four elevators of metal construction, each 17 feet high, equipped with cups.

The flow chart (Figure 1) indicates the milling process in sequence.

Local materials were used for construction as much as possible. Total wood construction was ruled out, because of tropical conditions, such as heavy rainfall, insect trouble and high maintenance expenses. Sun - dried clay blocks were believed to be lacking in strength. A combination of reinforced concrete, concrete blocks, wood and asbestos was used.

In designing the layout of the plant (Figure 2), drying facilities were limited to a concrete slab, 50 feet x 40 feet, which should be sufficient for the size of the plant.

Consideration was given to incorporation of a bulk storage as compared to sack warehousing. The former has definite advantages, but, due to lack of sufficient funds, it was deemed advisable to adopt the latter method. Supplementary bulk storage may be added later, if conditions warrant.

Facilities for fumigation were not included in the set-up, on the ground that sound warehousing practices would be sufficient to prevent insect damages.

By the end of 1953, the plant was completed, with all necessary equipment installed, and began operation in March 1954.

The two counterparts, who were assigned to the project, were given FAO fellowships to go to Sierra Leone, for a 3-month period, to study storage, processing and marketing practices. The climatic conditions there are similar to those in their own country. Upon returning one served as a paddy buyer and the other as a cashier and stock control clerk.

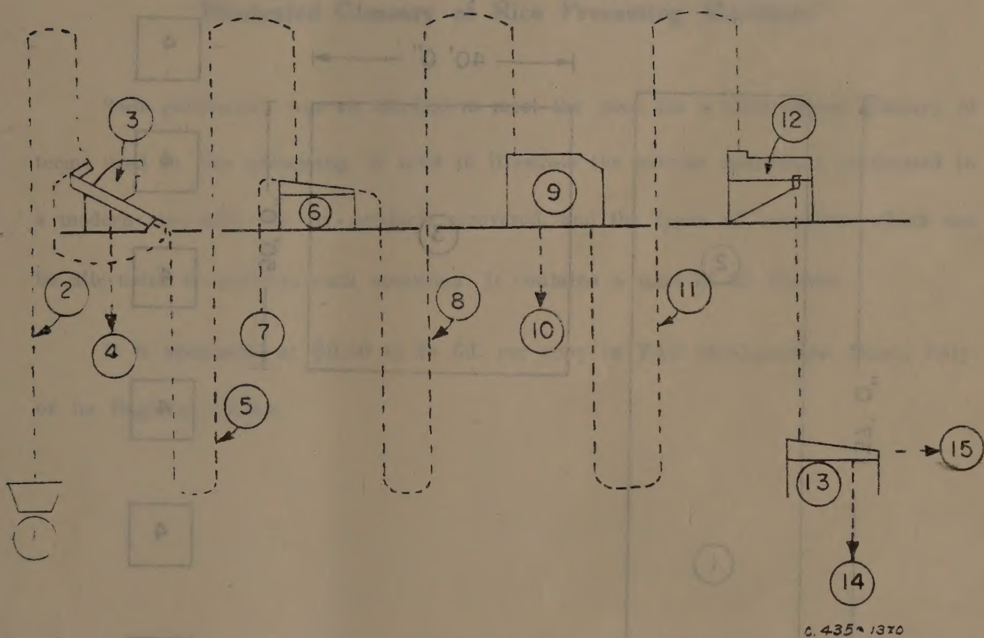
Before his termination, the FAO expert conducted a six week training course on rice mill operation and management for the local staff.

References

1. T.T. Hogan. Report to the Government of Liberia on the installation and utilization of a rice processing pilot plant. FAO Report No. 289, Rome, August 1954.

2. World Crops, Vol. 6, No. 6, p. 248, June 1954.

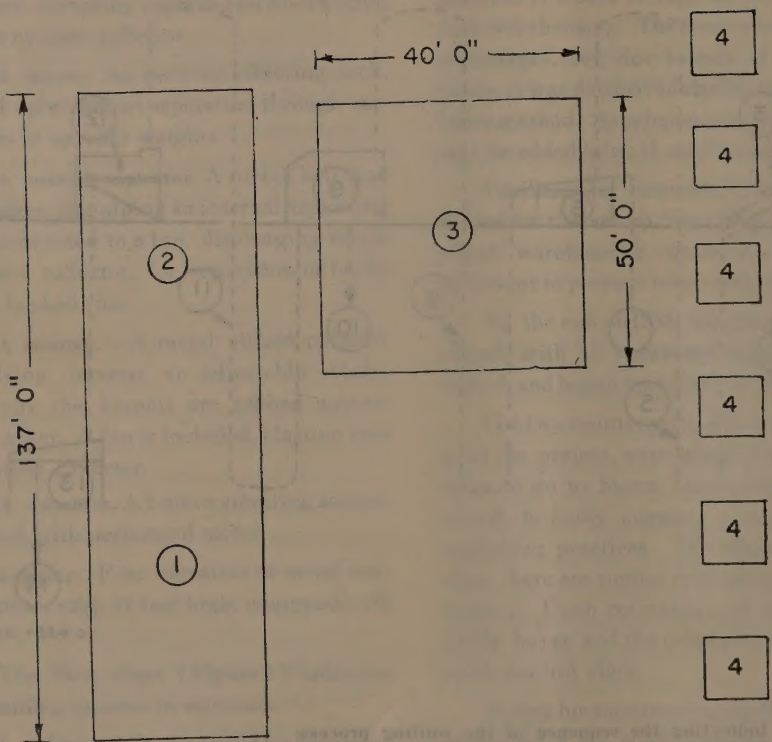
Figure 1. Flow Chart



Flow chart indicating the sequence of the milling process:

(1) Paddy intake; (2) Elevating leg; (3) Cleaner; (4) Refuse;
(5) Elevating leg; (6) Stoner; (7) Stones and metal; (8) Elevating leg;
(9) Husker; (10) Husks; (11) Elevating leg; (12) Scourer.
(13) Classifier; (14) Chits; (15) Clean rice.

Figure 2. Building Layout



Building layout:

(1) Mill section; (2) Warehouse section;
(3) Drying slab; (4) Six kitchens.

FAO PUBLICATION

"Illustrated Glossary of Rice Processing Machines"

This publication was an attempt to meet the need for a multilingual glossary of terms used in rice processing. It tries to illustrate the various operations performed in a modern rice mill, the by-products recovered, and the types of machines which can be alternated to perform each operation. It contains a total of 23 figures.

It is obtainable at $0.50 or 2s. 6d. per copy in FAO Headquarters, Rome, Italy. or its Regional Offices.

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